Egyptian Journal of Ear, Nose, Throat and Allied Sciences (2014) **15**, 23–28

Egyptian Society of Ear, Nose, Throat and Allied Sciences

Egyptian Journal of Ear, Nose, Throat and Allied Sciences

www.ejentas.com

ORIGINAL ARTICLE

The role of different materials for prevention of synechiae following endoscopic sinus surgery

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Received 16 September 2013; accepted 2 December 2013
Available online 10 January 2014

KEYWORDS

Endoscopic sinus surgery;
Nasal packing;
Synechiae;
Granulation

Abstract *Background:* Endoscopic sinus surgery (ESS) has become the treatment of choice for nasal polyposis and chronic rhinosinusitis that cannot be adequately managed with medical therapy. Nasal packing is usually placed after ESS to prevent synechiae formation and postoperative bleeding and to support wound healing.

Objectives: This study was done to evaluate the effect of different materials on the formation of synechiae and excessive granulation tissue in the middle meatus in patients who had undergone ESS.

Methods: A total of 90 patients who had undergone ESS were studied prospectively. At the end of ESS each patient was packed with one of the three different materials randomly. The outcome variable was the formation of synechiae and excessive granulation tissue in the middle meatus, which was identified from endoscopic evaluations performed 3–4 weeks and 10–12 weeks after surgery.

Results: We observed significant intergroup differences in the effect on the formation of synechiae in the middle meatus. The nasopore group was superior to the other two groups and there is a significant reduction in synechiae formation in the nasopore group than both other groups.

Conclusion: Among patients who had undergone ESS for rhinosinusitis with or without polyps, the incidence of synechiae and excessive granulation tissue in the middle meatus in the patients who received nasopore packing was less to that of synechiae in the patients who received merocel and mitomycin C.

1. Introduction

Endoscopic sinus surgery (ESS) has become the standard treatment for the management of medically refractory chronic rhinosinusitis and nasal polyps. The most common complications of ESS are postoperative formation of synechiae in the middle meatus with incidence ranges from 1% to 36%.[1] Synechiae in the middle meatus can block the normal mucociliary drainage pathway of the sinuses and lead to disease recurrence.

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Peer review under responsibility of Egyptian Society of Ear, Nose, Throat and Allied Sciences.

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http://dx.doi.org/10.1016/j.ejenta.2013.12.001

Numerous techniques including suture medialization, partial resection of the middle turbinate, and nasal packing in the middle meatus, have been used to prevent postoperative synechiae formation.[2] Nasal packing remains the most common procedure to prevent synechiae formation. Conventional packing products, such as vaseline gauze strip and expandable polyvinyl acetate (Merocel) are non-absorbable materials. New biodegradable packing materials with various degrees of efficacy have also been developed, for example, Floseal, MeroGel/Meropak, Nasopore (Polyganics, The Netherlands); and carboxymethylcellulose.[3]

2. Objectives

The aim of this study was done to evaluate the effect of three different materials [Mitomycin c, Merocel, and Nasopore (Polyganics)] on the formation of synechiae and excessive granulation tissue in the middle meatus in patients who had undergone ESS.

3. Patients and methods

This study was held at Benha University hospitals, in the period from January 2012 to March 2013. The ethical committee of Benha Medical School approved the study and informed consents signed by all patients were taken. The study was conducted on 90 patients who had undergone ESS. 6 patients were lost during the follow up and were replaced. All patients were divided into three groups as; 30 packed with Nasopore, 30 with MMC and the last 30 with Merocel. The Lund-Mackay computed tomography (CT) staging system (0/1/2, per side) was used to assess the findings of the preoperative CT, and that of endoscopic evaluations for the nasal polyp grading system (0; no visible polyps, 1; polyps confined to the middle meatus, 2; polyps that had grown beyond the middle meatus but were not completely obstructing the nasal cavity, 3; polyps completely obstructing the nasal cavity).[4]

Patient exclusion criteria include patients with concha bulosa, history of sino-nasal trauma, previous sino-nasal surgery, patients with unilateral sinusitis such as maxillary sinusitis of dental origin, patients whom had underlying systemic disease such as; cystic fibrosis, immune deficiency and ciliary movement disorder, patients with chronic specific inflammatory disease such as rhinoscleroma, T.B, syphilis, history of bleeding disorders and patients with complicated sinusitis.

All patients were admitted to our department to undergo ESS, and at the end of the surgery, the chosen packing material was impregnated with antibiotics and introduced in the middle meatus. The merocel packs were removed 48 hours after surgery. In contrast, nasopore was left in place, if remnants were found it was suctioned out during the patient's follow-up visit (5:10 days after discharge). While in the MMC group a piece of cotton soaked in 1 ml of MMC in a concentration of 0.5 mg/ml was placed in the middle meatus. After a period of 5 minutes, the cotton pieces were removed and the nasal cavity was irrigated with 30 ml of sterile normal saline. The postoperative regimens for all patients were quite similar, including 2-weeks oral antibiotic therapy along with the administration of a topical nasal steroid, isotonic saline irrigation and regular follow-up examinations. Subjective evaluation for all patients was carried out 12 weeks postoperatively including; nasal obstruction, anterior nasal discharge and posterior nasal discharge. Objective assessment of all patients was performed. Crusts, unhealthy mucosa, excessive granulation tissue and synechiae in the middle meatus were identified from the medical records of the endoscopic evaluations performed 3–4 weeks and 10–12 weeks after surgery. Granulation tissue formation is common during the mucosal healing process; therefore, we considered only those cases that showed excessive granulation tissue involving more than 10% of the middle meatus.[5]

Statistical analysis of the data obtained in this study was performed. Comparisons of all the parameters, including the outcome variables for the formation of synechiae and excessive granulation tissue in the middle meatus for the packing material groups were performed.

4. Results

A total of 90 patient were included in this study 6 were lost during follow up and were replaced, they were 35 female (39%) and 55 male (61%) ranging in age from 19 to 49 years with mean of 35 y, median 36 y and Standard Deviation 9. with bilateral chronic rhinosinusitis with or without sinonasal polyposis. Functional endoscopic sinus surgery had been done for all patients (see Table 1).

Table 1 Sex distribution in the study.

Sex	No	%
Male	55	61
Female	35	39
Total	90	100.0

The presenting clinical symptoms in patients of our study are bilateral nasal obstruction which presented in 67 patients (74.4%), anterior nasal discharge presented in 32 patients (35.5%), posterior nasal discharge presented in 27 patients (30), headache presented in 63 patients (70%) and facial pain presented in 16 patients (17.7) (see Fig. 1, Table 2).

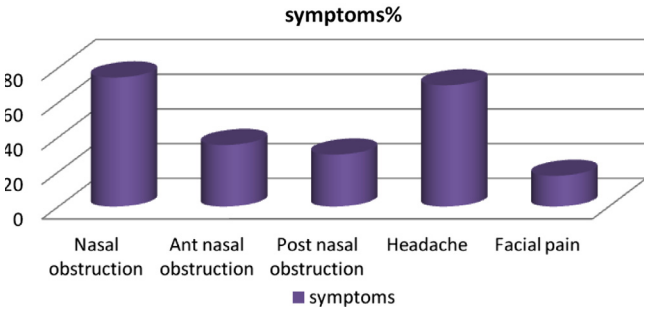

Figure 1 Clinical presenting symptoms.

Table 2 Clinical presenting symptoms in patients of our study.

Symptoms	No (90)	%
Nasal obstruction	67	74.4
Anterior nasal discharge	32	35.5
Posterior nasal discharge	27	30
Headache	63	70
Facial pain	16	17.7

The pre-operative endoscopic findings in this study group which are: congested nasal mucosa presented in 47 patients (52.2%), polypi presented in 61 patients (67.7%) nasal discharge presented in 51 patients (56.6%), enlarged MT presented in 27 patients (30%) and enlarged IT presented in 14 (15.5%) (see Table 3, Fig. 2).

Table 3 Pre-operative endoscopic findings.

Findings	No (90)	%
Congested mucosa	47	52.2
Polypi	61	67.7
Discharge in middle meatus	51	56.6
Enlarged middle turbinate	27	30
Enlarged inferior turbinate	14	15.5

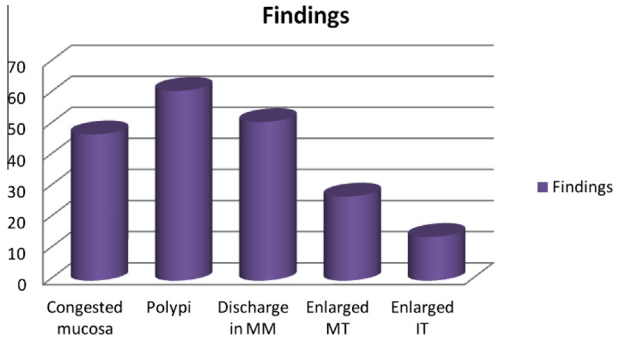

Figure 2 Pre-operative endoscopic findings.

The pre-operative C.T finding in patients of our study: Maxillary sinusitis presented in 90 patients (100%), these patients have mucosal thickening, partial or complete opacifications. Anterior ethmoiditis presented in 65 patients (72.2%), posterior ethmoiditis presented in 49 patients (54.4%), Frontal sinusitis presented in 13 patients (14.4%) and sphenoiditis presented in 9 patients (10%). All patients have obliterated osteometal complex (see Fig. 3, Table 4).

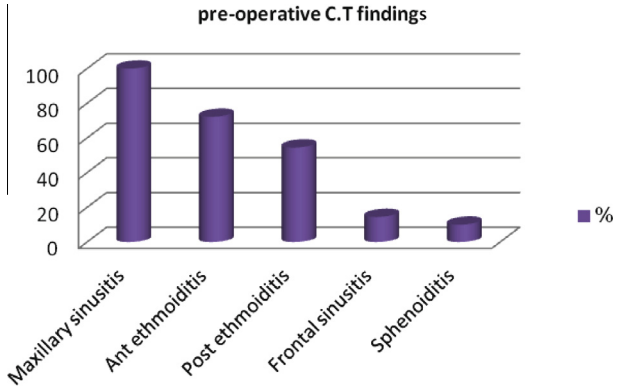

Figure 3 Pre-operative C.T findings in patients of our study.

Table 4 Pre-operative C.T findings in patients of our study.

	No (90)	Total = 90 pt
Maxillary sinusitis	90	100.0
Ant ethmoiditis	65	72.2
Post ethmoiditis	49	54.4
Frontal sinusitis	13	14.4
Sphenoiditis	9	10

The subjective assessment of patients 3 months after FESS; nasal obstruction presented in only 4 patients in the Nasopore group (13.3%), 7 patients in the MMC group (23.3%), and 9 patients in the Merocel group (22.2%) also anterior nasal discharge presented in only 3 patients in the Nasopore group (10%), 6 patients in the MMC group (20%) and 8 patients in the Merocel group (26.6%) (see Figs. 4, 5 and Table 5).

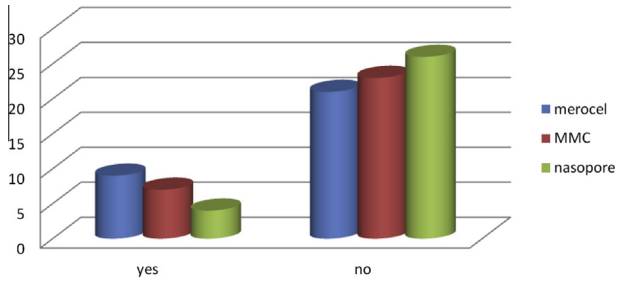

Figure 4 Subjective assessment of patients 3 months after FESS regarding to nasal obstruction.

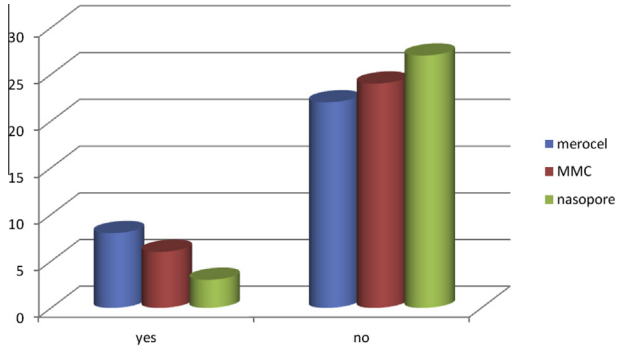

Figure 5 Subjective assessment of patients 3 months after FESS regarding anterior nasal discharge.

Table 5 Subjective assessment of the patients 3 months after FESS.

Symptoms		Nasopore (n = 30)		MMC (n = 30)		Merocel (n = 30)		Total (n = 90)	
		No	%	No	%	No	%	No	%
Nasal obstruction	+VE	4	13.3	7	23.3	9	30	20	22.2
	−VE	26	86.6	23	76.7	21	70	70	77.8
Anterior nasal discharge	+VE	3	10.0	6	20	8	26.6	17	18.9
	−VE	27	90.0	24	80	22	73.4	73	81.1

Objective endoscopic assessment of the patients 3 months after ESS: the granulations presented in 5 patients (16.7) of the nasopore group, 8 patients (26.7%) of the MMC group and 10 patients (33.3%) of the Merocel group.

The synechiae presented in 3 patients (10%) of the nasopore group, 8 patients (26.7%) of the MMC group and 10 patients (33.3%) of the Merocel group.

Unhealthy mucosa presented in 5 patients (16.7%) of the nasopore group, 6 patients (20.0%) of the MMC group and 7 patients (23.3%) of the Merocel group.

The crusts presented in 5 patients (16.7%) of the nasopore group, 6 patients (20.0%) of the MMC group and 7 patients (23.3%) of the Merocel group (see Table 6, Figs. 6–13).

Table 6 Objective evaluation by endoscopy three months after ESS.

Findings		Nasopore		MMC		Merocel		Total	
		No = 30	%	No = 30	%	No = 30	%	No = 90	%
Granulations	+VE	5	16.7	8	26.7	10	33.3	21	23.3
	−VE	25	83.3	22	73.3	20	66.7	69	76.7
Synechiae	+VE	3	10	8	26.7	10	33.3	21	23.3
	−VE	27	90	22	73.3	20	66.7	69	76.7
Unhealthy mucosa	+VE	5	16.7	6	20.0	7	23.3	18	20
	−VE	25	83.3	24	80.0	23	76.7	72	80
Crusts	+VE	5	16.7	6	20.0	7	23.3	18	20
	−VE	25	83.3	24	80.0	23	76.7	72	80

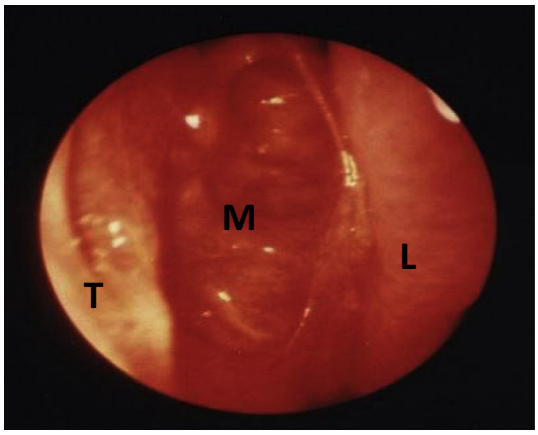

Figure 6 Endoscopic evaluation showing healthy, clean middle meatus (M), healthy lateral nasal wall (L), and healthy lateral surface of middle turbinate (T) after 3 month in the nasopore group.

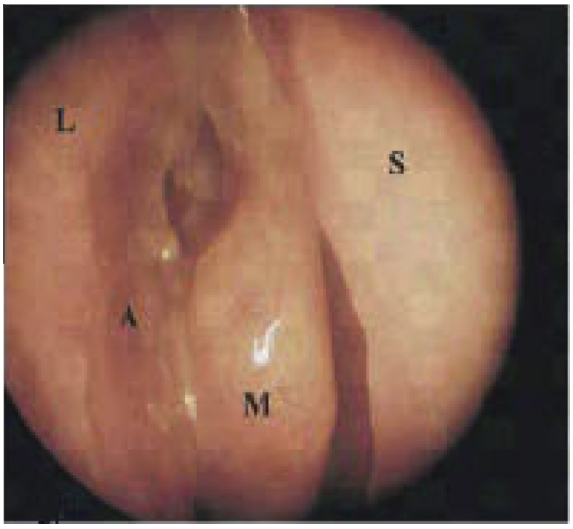

Figure 7 Endoscopic view of the right nasal cavity showing adhesions between the lateral nasal wall and the middle turbinate (Merocel group) 3 months after FESS (L) lateral nasal wall, (A) adhesion, (S) Septum, and (M) Middle turbinate.

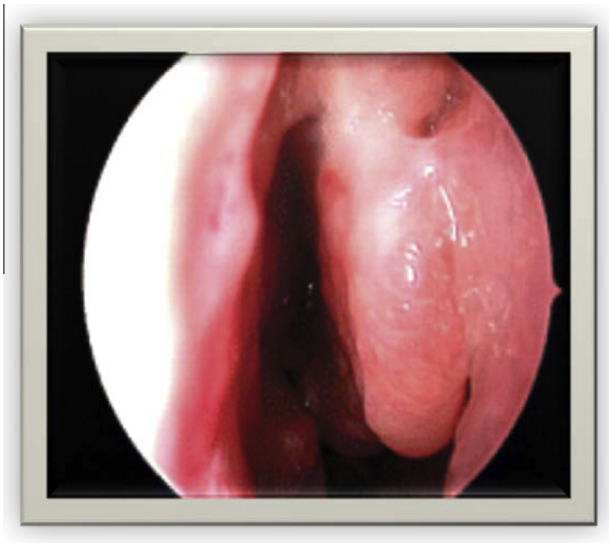

Figure 8 Endoscopic view of the right nasal cavity showing adhesions between the lateral nasal wall and the middle turbinate (mitomycin group) 3 months after FESS.

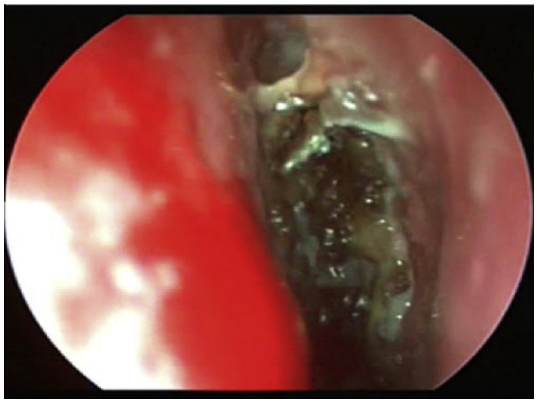

Figure 9 Endoscopic view of the right nasal cavity showing crusts filling the nasal cavity and unhealthy mucosa in the merocel group 3 months after FESS.

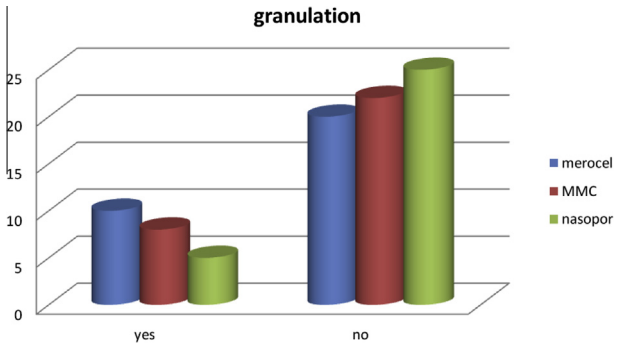

Figure 10 Endoscopic assessment of the granulations 3 month after FESS.

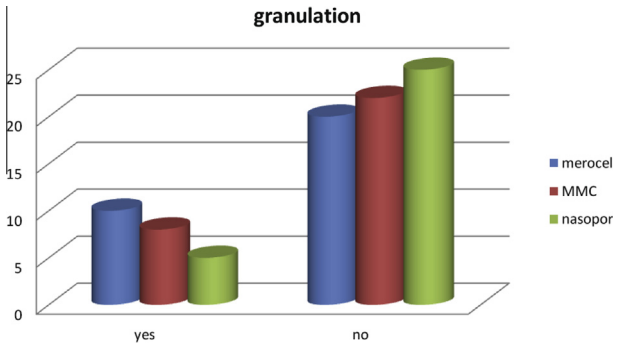

Figure 12 Endoscopic assessment for unhealthy mucosa 3 month after FESS.

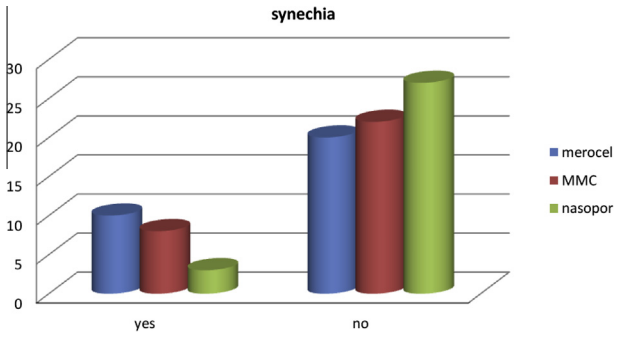

Figure 11 Endoscopic assessment of the synechiae 3 month after FESS.

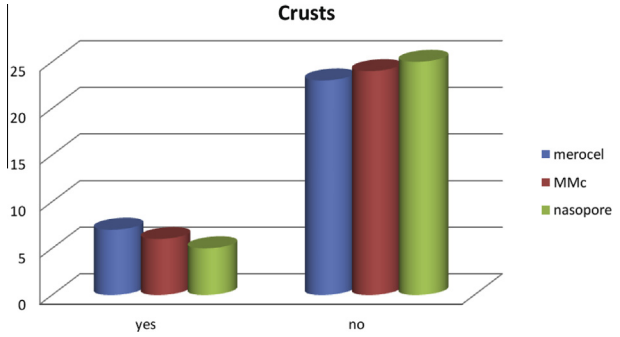

Figure 13 Endoscopic assessment for the crusts 3 month after ESS.

5. Discussion

The surgical outcomes in ESS remain dependent on successful wound healing without excessive synechiae formation. Many parameters have been used to determine the effect of nasal packing on wound healing. Wormald et al.[6] set up a sheep model of sinusitis and performed serial mucosal biopsies for light and electron microscopic evaluations. They choose the degree of mucosal reepithelialization, height of the epithelium, percentage of the area covered by cilia, and the maturity of the cilia as the parameters to investigate the process of wound healing. However, serial biopsies cannot be easily performed in a human clinical study. Wormald et al.[7] selected synechiae formation, mucosal edema, and infection as the parameters for analyses. Other authors have used synechiae in the middle meatus and formation of granulation tissue as the parameters to assess healing.[8,9] In the present study, we adopted the formation of synechiae and excessive granulation tissue in the middle meatus as the outcome variables to assess the effects of the three different materials.

To assess the effect of these materials on synechiae prevention, Miller et al.[10] conducted a blinded randomized controlled trial to compare the effects of merogel and merocel packing in 37 patients who had undergone ESS. They found that the rate of synechiae formation in both groups at 8 weeks after the operation was approximately 8%, and the intergroup difference was not statistically significant.

Berlucchi et al.[11] performed a prospective randomized controlled study comparing the effects of merogel and standard non absorbable nasal packing at 2, 4, and 12 weeks after ESS in 66 patients. They found lower rates of nasal synechiae formation in the Merogel group at both 4 and 12 weeks after the operation. Similarly, Chandra et al.[8] performed a double-blinded randomized controlled trial comparing the effects of floseal (Baxter, Alexander Court Hayward, CA, USA) and thrombin-soaked gelatin foam in 20 patients, and they found that floseal significantly increased adhesion (p 0.006) and granulation tissue formation (p 0.007).

Bugten et al.[9] compared the effects of non absorbable packing with no packing after ESS; in their study, endoscopic video recordings obtained 10–14 weeks after surgery showed seven (7/62) adhesions in the non absorbable packing group and 29 (29/54) adhesions in the control (no packing) group ($p < 0.001$).

In a prospective randomized controlled study published in 2006, Wormald et al.[7] tested the effects of merogel on one side and no packing on the other side in 42 patients with chronic rhinosinusitis who had undergone ESS. The researchers did not find any significant differences among the incidence of synechiae formation on the two sides at 2 weeks, 4 weeks, and 6–8 weeks after surgery.

In a study by Anand et al.[12] on 29 patients with chronic rhinosinusitis resistant to medical treatment, MMC impregnated mesh and saline impregnated mesh randomly were used for each side of nasal cavity at the end of the surgery. In their study the main outcome measure was adhesions, while in our study, in addition to adhesions, unhealthy mucosa and crusts were also assessed.

They showed that the incidence of adhesion (9 cases of 29) between the two sides has no significant statistical difference.

In another study by Kim et al.[13] on 20 patients, the effects of mitomycin C were evaluated on anterostomy size and were found to be effective only in the first month after surgery. But after 6 months (long term) follow up, MMC has no effect in reducing incidence of narrowing or obstruction of antrostomy. Also suggested that 70% of fibroblasts survive after a 5 minute MMC application (0.4 mg/ml) with an evidence of regrowth within 2 to 3 days.

Konstantinidis et al.[14] assessed the efficacy of MMC using a two-stage application procedure allowing a more prolonged effect on the mucosa of the middle meatus. They reported that wound healing in the postoperative period after endoscopic sinus surgery is a prolonged and complex process mediated by several cell types. Although this period can be long and stenosis has been reported years after surgery, the first 6–8 weeks up to 3 months are the most important.

In their study intraoperative and postoperative use of topical mitomycin C in concentration 0.4 and 0.8 mg/ml applied over 5 min have been shown to decrease adhesion formation in patients undergoing functional endoscopic sinus surgery. This study shows the effect of mitomycin-C in prevention of synechiae formation and closer of ostiomeatal complex. They found the more the concentration of MMC, the better the result.

Overall, the incidence of synechiae formation after ESS differs considerably from trial to trial, and the optimal material for nasal packing is still a matter of debate. Because none of the previous studies have compared the effects of merocel and nasopore with those of the MMC, we retrospectively analyzed our data and found significant differences among these three materials with regard to their ability to reduce synechiae formation.

Granulation tissue formation is an essential stage during the mucosal healing process after ESS, and assessment of this process can indicate the healing status. Some authors have compared the wound-healing efficacies of absorbable packing and no packing in patients who had undergone ESS.

Kastl et al.[15] performed a study in 26 patients who underwent ESS; these patients were randomized to receive carboxymethylcellulose on one side and no packing on the opposite side. No significant differences were found between the wound-healing outcome measures, including granulation tissue formation, for the two sides.

However, none of these studies directly compared the granulation tissue formation observed after packing with absorbable material with that observed after packing with traditional nonabsorbable material. In the present study, we defined excessive granulation tissue formation ($>10\%$ of the middle meatus) as one of the outcome variables. We did not consider the cases showing mild granulation tissue formation, because mild granulation tissue was less likely to obstruct the sinus drainage pathway and impede the healing process.

6. Conclusion

In patients undergoing ESS, using of a biodegradable synthetic polyurethane foam can significantly reduce the risk of synechiae formation more than using merocel pack or mitomycin-C.

Conflict of interest

None.

References

1. Anand VK, Tabaee A, Kacker A, Newman JG, Huang C. The role of mitomycin C in preventing synechia and stenosis after endoscopic sinus surgery. *Am J Rhinol*. 2004;18:311–314.
2. Catalano PJ, Roffman EJ. Evaluation of middle meatal stenting after minimally invasive sinus techniques (MIST). *Otolaryngol Head Neck Surg*. 2003;128:875–881.
3. Weber R, Keerl R, Hochapfel F, Draf W, Toffel PH. Packing in endonasal surgery. *Am J Otolaryngol*. 2001;22:306–320.
4. Tom LW, Palasti S, Potsic WP, Handler SD, Wetmore RF. The effects of gelatin film stents in the middle meatus. *Am J Rhinol*. 1997;11:229–232.
5. Lund VJ, Kennedy DW. Staging for rhinosinusitis. *Otolaryngol Head Neck Surg*. 1997;117:535–540.
6. McIntosh D, Cowin A, Adams D, Wormald PJ. The effect of an expandable polyvinyl acetate (merocel) pack on the healing of the nasal mucosa of sheep. *Am J Rhinol*. 2005;19:577–581.
7. Wormald PJ, Boustred RN, Le T, Hawke L, Sacks R. The use of hyaluronic acid nasal packs in patients after endoscopic sinus surgery. *Am J Rhinol*. 2006;20:7–10.
8. Chandra RK, Conley DB, Kern RC. The effect of FloSeal on mucosal healing after endoscopic sinus surgery: a comparison with thrombin soaked gelatin foam. *Am J Rhinol*. 2003;17:51–55.
9. Bugten V, Nordgard S, Skogvoll E, Steinsvag S. Effects of nonabsorbable packing in middle meatus after sinus surgery. *Laryngoscope*. 2006;116:83–88.
10. Miller RS, Steward DL, Tami TA, Sillars MJ, Seiden AM, Shete M. The clinical effects of hyaluronic acid ester nasal dressing (merogel) on intranasal wound healing after functional endoscopic sinus surgery. *Otolaryngol Head Neck Surg*. 2003;128:862–869.
11. Berlucchi M, Castelnuovo P, Vincenzi A, Morra B, Pasquini E. Endoscopic outcomes of resorbable nasal packing after functional endoscopic sinus surgery: a multicenter prospective randomized controlled study. *Eur Arch Otorhinolaryngol*. 2009;266:839–845.
12. Anand VK, Tabaee A, Kacker A, Newman JG, Huang C. The role of mitomycin C in preventing synechia and stenosis after endoscopic sinus surgery. *Am J Rhinol*. 2004;18(5):311–314.
13. Kim S-T, Gang I-G, Cha H-E, Ha J-S, Chung Y-S. Effect of mitomycin C on the size of antrostomy after endoscopic sinus surgery. *Ann Otol Rhinol Laryngol*. 2006;115(9):673–678.
14. Konstantinidis I, Tsakiropoulou E, Vital I, Triaridis S, Constantinidis J. Intra- and postoperative application of mitomycin C in the middle meatus reduces adhesions and antrostomy stenosis after FESS. *Rhinology*. 2008;46(2):107–111.
15. Kastl KG, Betz CS, Siedek V, Leunig A. Effect of carboxymethylcellulose nasal packing on wound healing after functional endoscopic sinus surgery. *Am J Rhinol Allergy*. 2009;23:80–84.